

### Filter Device

The invention relates to a filter device for use of filter elements which can be held in a filter housing with a filter inlet and a filter outlet for the fluid to be filtered, flow through the filter elements being possible in both directions for filtration or backflushing, and some filter elements performing filtration in the filtration position and at least one other filter element can be backflushed in a backflushing position to clean out its effective filter surface.

A generic filter device, a reversible flow filter device in particular, is disclosed in WO 98/42426. In the known reversible flow filter device, some of the filter elements used are made conical, especially in the form of so-called tubular, wedge-wire screen filter elements. As a result of the conical execution, the distance between the individual conical wedge-wire screen filter elements or between them and cylindrical filter elements is increased, with the result that the outflow space in the filter housing is enlarged and consequently the offlow resistance in filter operation is reduced. During backflushing the conical filter element is obviously superior to a cylindrical one. First of all, this is because of the relatively larger exit cross section of the conical filter elements compared to cylindrical ones for the same filter surface. Since the exit cross section for the conical filter elements compared to the entry cross section formed by the filter surface, that is to say, the free element area, is however relatively small, depending on the magnitude of the flow resistance of the slotted tube a

bottleneck forms in which by large part of the system pressure falling off. Therefore smaller pressure losses occur; this is more favorable in terms of energy during backflushing.

During backflushing a large part of the volumetric throughput for conical and cylindrical filter elements is achieved basically on the bottom end of the filter. The volumetric flows then decrease very quickly. Since the conical element is essentially backflushed much farther, the velocity gradient is additionally smaller so that with the inclusion of the velocity profiles relative to the filter surface as a result of the element conicity an additional cleaning effect compared to cylindrical elements is achieved. Due to the essentially constant velocity achieved in the cleaning of the conical filter elements this takes place carefully; this prolongs the service life of these filter elements.

During backflushing, preferably all filter elements are regenerated in succession in chronological order. During backflushing of individual elements, filtration is continued over the remaining slotted tubes so that filtration operation in the known solution is never interrupted. The overpressure prevailing in the reversible flow filter device during the backflushing phase allows a small partial stream of filtrate to flow through the filter element to be cleaned in the reverse direction, the dirt being detached from the element and carried away. The amount of discharge which accompanies backflushing cannot be exactly metered and is based on empirical values. Generally backflushing takes longer with large amounts in order to ensure reliable cleaning.

In the known solutions (WO 98/42426, DE 195 42 578 and DE 199 56 859) a hollow arm is pivoted to under one free entry cross section of the filter element to be cleaned and accordingly backflushed to remove the quantity of dirty backflushed fluid and from there the backflushed amount travels via the corresponding connecting pieces out of the filter housing for further treatment. In the known solutions, sealing problems arise with respect to connection of the flushing arm to the respective filter element to be backflushed, and otherwise the pertinent discharge means

for the backflushed amount accordingly requires a large amount of installation space. Here, with respect to the number of fluid deflections for the backflushed amount, operating states which are unfavorable in terms of energy occur in the known solutions.

On the basis of this prior art, the object of the invention is to further improve the known, generic filter devices while maintaining the described advantages in the prior art such that sealing problems in backflushing are for the most part prevented, that backflushing which is favorable in terms of energy is enabled, and that only little installation space is required on the filter device for backflushing. This object is achieved by a filter device with the features of claim 1 in its entirety.

In that, as specified in the characterizing part of claim 1, the individual filter elements are moved in succession from their filtration position into the backflushing position and back into the filtration position by means of a pivoting device, the filter elements are moved individually in succession in time into the backflushing position and an arm-like backflushing means is no longer pivoted to the individual filter elements for the backflushing process. Since the pertinent pivoting motion for the filter elements can be easily controlled, possible sealing problems can be better managed. Furthermore, the filter device as claimed in the invention relative to the seal configuration and the pivoting drive for the filter elements requires less installation space within the filter housing so that even when space conditions are tight these filter devices with a backflush mode can be implemented; this has posed problems in the past. Furthermore, with the solution as claimed in the invention improved inflow and outflow behavior for the amounts of fluid to be controlled is achieved, even with respect to the backflushing amounts; in terms of energy this benefits the filtration operation of the overall filter device.

While in the known reversible flow filter devices for backflushing there is a drivable flushing arm which can be moved in succession to under the free inlet cross sections of the filter elements for fluid exit of dirty fluid, with the filter device as claimed in the invention the pivoting

device requires a correspondingly designed receiving element for holding the filter elements, which then enables the individual filter elements for backflushing to approach the backflushing station by means of a drive pivotable around a pivoting axis within the filter housing.

By preference provision is made such that the receiving element has two opposing end parts between which the individual filter elements extend, at least the end part which is facing the filter inlet being pivotably guided along the interior of the filter housing by way of a sealing means. In this way a prompt replacement process for used filter elements is achieved by way of the end parts of the receiving element, if the filter elements are to be replaced by new elements and the indicated sealing means can be designed to be reliable in terms of its sealing action and can be operated over the long term.

In one preferred embodiment of the filter device as claimed in the invention, the filter elements are configured within the filter housing coaxially to the pivoting axis which is formed by a rod-like drive part which detachably connects the two end parts to each other. Preferably the drive part can be driven by a motor, especially a pneumatic motor, with alternating back and forth motion for is driven part, which motion can be converted by means of a free-wheeling device into a constant drive motion in one driving direction for the drive part of the receiving element. With this configuration a drive concept for moving the individual filter elements from their filtration position into the backflushing position and from there again into the filtration position can be achieved in a very economical and space-saving manner. This drive concept also requires less energy.

In another especially preferred embodiment of the filter device as claimed in the invention, part of the filter housing is designed as a cover and towards its free ends has a cavity with an axial extension which corresponds more or less to the overall length of the filter elements. In filtration operation in which flow takes place through the preferably conical wedge-wire screen filter elements from the inside to the outside, in the top part of the filter housing a fluid collection space is

formed which offers few obstacles to filtration operation, and thus is extremely favorable viewed in terms of the overall energy balance of the filter device; this also applies to the case in which from there the corresponding amounts are used for backflushing operation, for which fluid is flowing through the filter element to be backflushed in the reverse sequence from the outside to the inside.

Other advantageous embodiments are the subject matter of the other dependent claims.

The filter device as claimed in the invention will be detailed below using one exemplary embodiment shown in the drawings. The figures are schematic and not to scale.

- FIG. 1            shows a longitudinal section through the filter device;
- FIG. 2            shows a perspective side view of the filter device as shown in FIG. 1 and
- FIG. 3            shows a top view of the filter device as shown in FIGS. 1 and 2, partially in a section, partially in a front view.

The filter device shown in FIG. 1, especially a reversible flow filter device, has a cylindrical housing 10 consisting of a top housing part 12 and a bottom housing part 14. The two housing parts 12, 14 can be detachably connected to each other via a detachable bracket clip 16 (compare FIG. 2). Furthermore, the housing 10 can be attached to other components, for example those of a hydraulic type, by way of the bottom housing part 14 by means of flange-like fastening parts 18. The filter housing 10 of the reversible flow filter device furthermore has a filter inlet 20 for the fluid to be filtered and a filter outlet 22 for the filtered fluid. Within the bottom housing part 14, diametrically opposite the longitudinal axis 24 to the filter inlet 20 there is a fluid outlet 26 via which a quantity of backflushing liquid can be withdrawn from the device.

Filter elements 28 which taper conically to the top are inserted into the filter device, also at least partially cylindrical filter elements (not shown) being able to replace the conical filter elements 28. The indicated conical filter elements 28 which can consist of wedge-wire screen filter elements are configured at distances from each other along a cylindrical arc (compare FIG. 3) within the filter housing 10. In an embodiment which is not detailed, the filter elements 28 can also be configured repeatedly divided into groups along cylindrical arcs. For the embodiment shown in the figures however there are a total of four filter elements 28 diametrically opposite each other viewed toward the longitudinal axis 24 of the device. Viewed in the direction of looking at FIG. 3, the top filter element 28 is shown in its backflushing position and the filter elements 28 located underneath are in their filtration position.

By means of a pivoting device which is designated as a whole as 30, it is possible to move the individual filter elements 28 in succession from their filtration position into the backflushing position and back into the filtration position, and the rotary motion can take place both clockwise and counterclockwise for the individual filter elements 28.

The pivoting device 30 itself has a receiving element 32 for holding the individual filter elements 28, the receiving element 32 being pivotably mounted within the filter housing 10 around a pivoting axis 36 by means of a drive or motor 34. This pivoting axis 36 is essentially congruent with the longitudinal axis 24 of the filter device.

The receiving element 32 has two opposing end parts 38, 40 between which the individual filter elements 28 extend, at least the end part 40 which is facing the filter inlet 20 is guided along the interior of the filter housing 10 via a sealing means 42. The respective end part 38, 40 is designed as a cylindrical plate and the lower end part 40 on the outer peripheral side has recesses for holding the sealing parts of the sealing means 42, in this way a sliding seal being attained between the interior of the filter housing 10 and the outer periphery of the lower end part 40.

As is to be seen especially from FIG. 3, the lower end part 40 has a kidney-shaped recess 44 which can be supplied with fluid from the filter inlet 20. As long as the three filter elements 28 with their lower free opening cross section 46 as shown in FIG. 3 are located over the kidney-shaped recess 44, the fluid to be filtered flows via the filter inlet 20 and the recess 44 as well as the lower opening cross section 46 into the interior of the respective filter element 28 and for this purpose flows through the filter elements 28 from the inside to the outside. Dirt which may be present in the fluid is deposited on the inner wall of the respective hollow filter element. The filter element 28 which is the upper one when viewed in the direction of looking at FIG. 3 is removed therefrom and the filtrate or clean fluid which is present in the filter housing is routed in the reverse direction, that is to say, from the outside to the inside, through the upper filter element 28 which is to be cleaned out, the fluid dirt which has been removed and obtained in this way traveling out of the interior of the filter element 28 which has been used for backflushing and in turn via its lower free opening cross section 46 in the direction of the fluid outlet 26 and accordingly out of the device.

For the pertinent transport of the backflushing fluid, the lower end part 40 has a circular through opening 48. On the opposing end, that is to say, toward the top, the individual filter elements 28 are closed and held in the upper end part 38 which in this respect has individual recesses 50 which the upper free ends of the filter elements 28 engage. The two end parts 38, 40 are detachably connected to each other along the pivoting axis 26 via a rod-like drive part 52. In this respect it would therefore also be possible, with the upper cover part 12 removed and the two end parts 38, 40 released from each other, to replace a used filter element 28 with a new element in the event this should become necessary. The pertinent drive part 52 can be driven by the drive 34 of the filter device which is designed in particular as a pneumatic motor.

This pneumatic motor is characterized in that its journal-like driven part 54, depending on the pump motion of the piston parts of the pneumatic motor, as a drive 34 executes alternating back and forth motion, and the pertinent back and forth motion then can be converted by means of a free-

wheeling device 56 into a constant drive motion in one driving direction for the drive part 52 of the receiving element 32. The free-wheeling means 56 is especially a free-wheeling sleeve which with its movable components couples the driven part 54 to the drive part 52. For this coupling, the rod-like drive part 52 viewed in the direction of looking at FIG. 1 on its bottom is coupled to a drive axis 58 which is guided to be able to turn or pivot in the lower housing part 14.

This free-wheeling sleeve of the free-wheeling device 56 under consideration is able to relay the alternating back and forth motion of the drive 34 in only one direction to the drive line of the pivoting device 30 consisting of the driven part 54, the drive axle 58 and the drive part 52. In the other direction the free-wheeling device 56 does not transmit any torque to the pertinent drive line. The free-wheeling sleeve used here with an inner star and individually sprung rollers which is however prior art is especially suited due to its low slip as far as entrainment of the drive axis 58. For the opposite rotary motion for the free-wheeling sleeve, then a moment is not delivered to the device or consequently to the drive line. These free-wheeling sleeves and free-wheeling devices 56 are prior art so that they will not be detailed here. The drive axis 58 can also be made in several parts in order to ensure interchangeability of parts of the pertinent axis when wear occurs.

With the indicated drive concept, it is therefore possible to provide alternative back and forth motion of the pneumatic motor as a drive 34 into pivoting motion by 90° at a time for the filter elements 28 by means of the pivoting device 30, in order in this way in succession to always clean out one filter element 28 at a time in the backflushing position and to maintain ordinary filtration operation with the other three filter elements. For a different number of filter elements 2, 3, or 5 and more, then different staggering for the rotary motion by way of the free-wheeling sleeve is necessary. Based on the kidney-shaped configuration of the recess 44 on the bottom end 40 it is moreover ensured that for the pertinent re-positioning motion filtration can largely continue with always three filter elements. The respective backflushing process for the filter element 28 can take place in a more or less continuous time intervals; but it is also possible to ascertain via difference

pressure measurements on the filter elements 28 when they are to be used for backflushing and the pertinent element could be delivered directly to the backflushing opening 48 with the corresponding control.

As follows furthermore from the sectional representation as shown in FIG. 1, the upper housing part 12 has a free cavity 60 with an axial extension which corresponds more or less to the overall length of the filter elements 28. This configuration has proven especially favorable in terms of energy and the resistance opposing the flow through the filter elements 28 in conventional filtration operation, formed by the resistance of parts of the housing 10, is thus distinctly reduced. Within the cavity 60 essentially laminar flow behavior occurs; this helps reduce the outflow resistance in conventional filtration operation.

The tubular wedge-wire screen filter elements which are preferably used have support rods which are tilted in the direction of the longitudinal axis 24 of the device and around which a wire section is wound into individual turns, with gaps through which fluid can pass being left open, in the area of each contact point of the wire profile with the support rod a weld spot being located. The gap size which is provided for the free fluid passage, that is to say, the distance between two gaps, prevents passage of dirt if the particle size exceeds the pertinent gap width. Dirt trapped in the gaps can then be removed from the filter device by way of the described backflushing operation. The filter element 28 which has been cleaned out in this way then moves from the backflushing position back into the filtration position and can be used there for further filtration use.